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Eastern Spruce

Forest Service

U. S. DEPARTMENT OF AGRICULTURE

EASTERN SPRUCE

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The three spruces, red, white, and black, are northern trees of medium or small size often collectively known as eastern spruce or as the eastern spruces. The wood of all three is light in weight and color, similar in properties, and especially suited to the manufacture of paper. Red spruce grows in the northeastern part of the United States and in eastern Canada. White and black spruce have a much more extensive distribution, including the northeastern part of the United States and nearly all of Canada and Alaska. Red spruce is cut in much greater quantities in the United States than the other two eastern spruces for both lumber and pulpwood. In locations where the eastern spruces grow in mixture they are commonly cut and sold together without distinction.

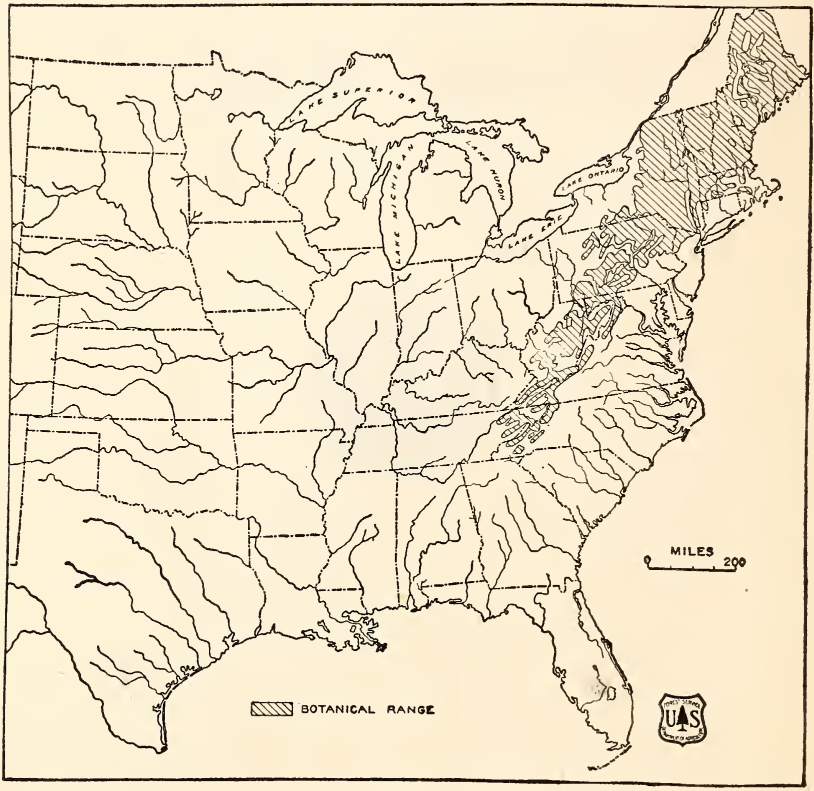

FIGURE 1.—Range of red spruce (Picea *rubra*) in the United States.

The eastern spruces were of little commercial importance until the supply of white pine in New England began to decline, when they came into use as a substitute for white pine for building purposes. Their use for making paper began about 1870, and they were until recently the leading paper-making woods in this country.[1] Large quantities of eastern spruce pulpwood are imported from Canada. The eastern spruces have been heavily cut for pulpwood and their available supply greatly reduced. The trees are particularly susceptible to fire on account of their thin bark and resinous exudations, and are subject to attack by fungi of various kinds and by insects, especially the spruce budworm. They will reproduce satisfactorily even under heavy shade and will live for a long time under such conditions, provided their requirements for moisture are met. They do not, however, make satisfactory growth in heavy shade beyond the seedling stage and for further development must have considerable overhead light.

Nomenclature.—Table 1 gives the names of the three eastern spruces.

Table 1.—*Names applied to eastern spruce*

Common name	Botanical name	Other names
Red spruce	*Picea rubra*	Yellow spruce. Spruce. West Virginia spruce. Canadian spruce. Eastern spruce.
White spruce	*Picea glauca*	Single spruce. Skunk spruce.[1] Cat spruce.[1] Spruce. Blue spruce. Eastern spruce. Canadian spruce.
Black spruce	*Picea mariana*	Blue spruce. Spruce. White spruce. Spruce pine. Eastern spruce. Bog spruce.

[1] Local name applied because of polecatlike odor given off by the foliage and young twigs, especially when crushed.

Distribution and growth.—Red spruce grows from New Brunswick and Nova Scotia in Canada, southward through New England and eastern New York, and along the Appalachian Mountains at increasingly higher altitudes to Georgia (fig. 1).

It occurs chiefly on well-drained uplands and mountain slopes and in the northern part of its range on the better drained soils near sea level. In many places it forms extensive pure or nearly pure dense stands. In other places it is found in mixed stands with the hardwoods, beech, birch, and maple as well as balsam fir, eastern hemlock, and tamarack. Mature red spruce approximately 200 years old reaches a diameter of about 18 inches in the North and a height of from 60 to 80 feet. In the southern Appalachians mature trees reach a diameter of about 24 inches. Trees over 100 feet in height and up to 4 feet in diameter have been noted. Red spruce grown under favorable conditions reaches an average diameter of 3.8 inches and an average height of 24 feet in 20 years and an average diameter of 9.3 inches and an average height of 61 feet in 60 years. Seed is generally produced in small quantities each year. A seedbed of moss and decayed wood with a plentiful supply of moisture and some shade is necessary for good reproduction.

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[1] The leading pulpwood in recent years in quantity consumed has been southern pine, with hemlock second and eastern spruce third.

White spruce grows from the coasts of Maine, Labrador, and Newfoundland westward through Alaska to Bering Strait. Its range extends as far south as the upper part of New England, New York, Minnesota, Wisconsin, and Michigan (fig. 2). A variety of white spruce known as western white spruce (*Picea glauca* var. *albertinana*) also occurs in small scattered stands in South Dakota, Wyoming, and southern Montana, and in larger stands extending down from Canada into northern Washington, Idaho, and Montana. In the United States white spruce commonly grows along the banks of streams and the edges of swamps. In Alaska, stands occur on low, swampy areas as well as on higher ground along streams, but under swampy conditions the trees are small and scrubby. Some seed is generally produced every year with occasional years of heavy production. Reproduction is usually good under mature white spruce stands where there is considerable moss and decaying wood, and the seedlings are hardy and grow rapidly. Under favorable conditions the trees may reach a height of 100 feet and a diameter of 30 inches. Ordinarily mature trees are 60 to 70 feet in height and 1 to 2 feet in diameter.

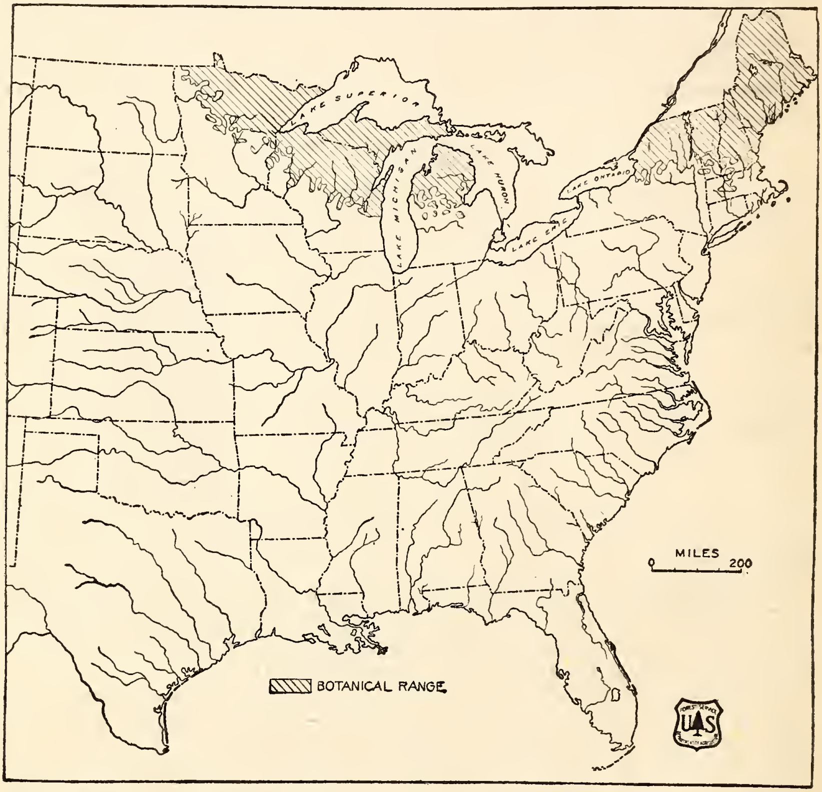

Figure 2.—Botanical range of white spruce (*Picea glauca*) in the United States.

Black spruce, like white spruce, grows principally in Canada with a range extending from the Atlantic coast into Alaska. In the United

States it grows in the Lake States, the New England States, New York, Pennsylvania, and southward in the Appalachian Mountains into West Virginia (fig. 3). Black spruce is primarily a swamp tree and is commonly found in cold, poorly drained bogs throughout its range where it can exist under conditions which most other trees cannot endure. Swamp-grown black spruce trees 200 years old are often only 2 inches to 6 inches in diameter. Under favorable conditions mature trees generally reach a height of about 60 feet and a diameter of about 15 inches. Seed is produced in moderate quantities each year. The chief requisite for germination is a moderate amount of shade and a moist soil, preferably formed from decayed wood and moss.

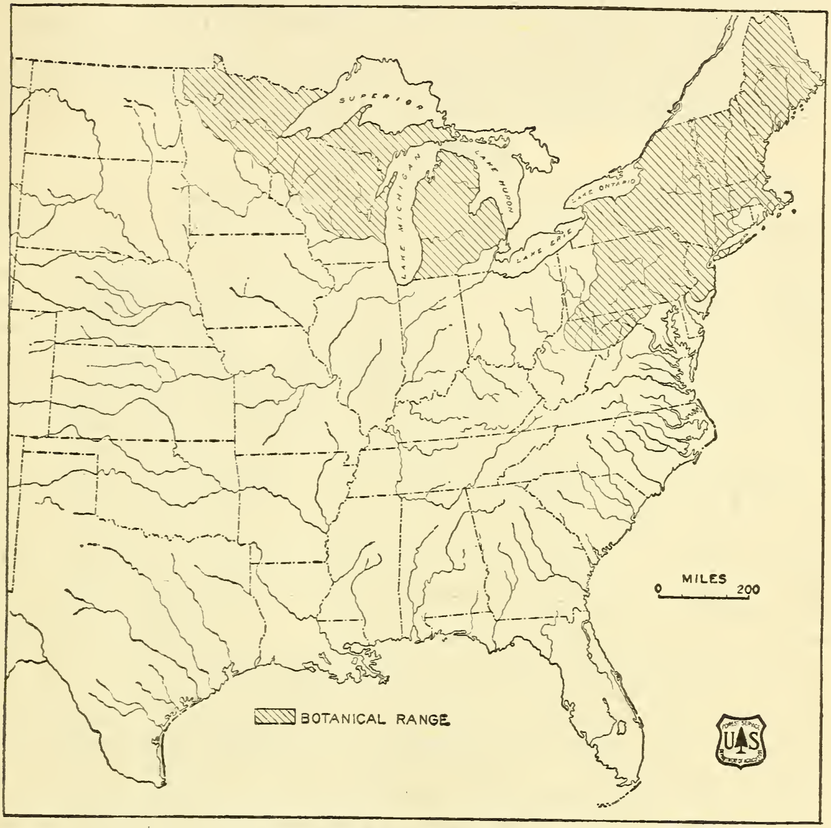

FIGURE 3.—Botanical range of black spruce (Picea *mariana*) in the United States.

Supply.—The amount of standing red, white, and black spruce and balsam fir of saw-timber size in the United States was recently estimated at 24,068,000,000 board feet.[2] Of this total probably three-quarters, or approximately 18,000,000,000 board feet, was spruce—largely red spruce. Very rough estimates of the distribution of the stand of red spruce are as follows: Maine, 7 billion feet; New York,

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[2] UNITED STATES CONGRESS, JOINT COMMITTEE ON FORESTRY. FOREST LANDS OF THE UNITED STATES. 77th Cong., 1st sess., Senate Doc. 32, 44 pp. 1941.

3 billion feet; New Hampshire, 2 billion feet; and smaller amounts aggregating between 2 and 3 billion feet in Vermont, North Carolina, Tennessee, Virginia, and West Virginia. The combined stand of white and black spruce based on a recent forest survey in the Lake States[3] is placed at 2⅓ billion feet, of which the greater part is white spruce. It is probable that another billion feet of black spruce and white spruce (principally black) is scattered through the New England States and farther south in the eastern spruce range.

In addition to material of saw-timber size, the stand of eastern spruce and balsam fir of cordwood size in the United States was estimated in 1930 at 69,878,000 cords.[4] Probably about three-fourths of this, or roughly 52,000,000 cords, was eastern spruce.

PRODUCTION

Lumber.—In 1869[5] the production of lumber from eastern spruce amounted to 440,000,000 board feet (fig. 4). Forty years later (1909) it had reached its maximum of 1,446,000,000 board feet. During the period from 1909 to 1933, production decreased rather uniformly and in 1932[6] fell to a minimum of 60,000,000 board feet. In 1942 it was 147,000,000 board feet and in 1943, 116,926,000 board feet. The average annual cut of eastern spruce for lumber in the 10-year period of 1933–42 was 121,000,000 board feet—about 8 percent of the maximum cut. The State of New York led in production from 1869 to 1899. Since then Maine has held first place,[7] with West Virginia, Vermont, or New Hampshire generally ranking second and third.

Pulpwood.—The amount of spruce pulpwood grown and consumed in the United States, including eastern spruce and Sitka spruce, increased from a few cords in 1880 to a maximum of 2,566,000 cords in 1920 or about 50 percent of all the domestic pulpwood used in that year.[8] Eastern spruce made up about 2,500,000 cords of the 1920 consumption and Sitka spruce the remainder. In 1940 the consumption of domestic spruce pulpwood was 2,045,000 cords or about 15 percent of the domestic pulpwood used.[9] The average annual consumption of domestic spruce pulpwood for the 10-year period 1931–1940 was 1,669,000 cords. During the same period the average annual consumption of Sitka spruce pulpwood is estimated at 110,000 cords, leaving an annual consumption of 1,559,000 cords for eastern spruce. This is equivalent to approximately 468,000,000 board feet[10]—an amount between four and five times as great as the average annual production of eastern spruce lumber during the same period. In 1944 the estimated eastern spruce pulpwood consumption was 2,000,000 cords.

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[3] Conducted by the Lake States Forest Experiment Station as a part of a Forest Survey of the United States.

[4] UNITED STATES CONGRESS. A NATIONAL PLAN FOR AMERICAN FORESTRY. 73d Cong., 1st sess., Senate Doc. 12, 2 v. 1933.

[5] The earliest year for which lumber production statistics on eastern spruce are available.

[6] A year of business depression.

[7] Except in 1940 and in 1943, when Vermont was first.

[8] The total consumption of pulpwood in the United States in 1920 amounted to 6,114,000 cords, including imports from Canada of about 922,000 cords of spruce and 178,000 cords of "poplar" (includes aspen, cottonwood, and balsam poplar).

[9] The total consumption of pulpwood in the United States in 1940 was 13.743,000 cords including imports of approximately 963.000 cords of spruce, 153,000 cords of hemlock, 109,000 cords of "poplar," 84,000 cords of balsam fir, and 63.000 cords of jack pine. The total consumption of pulpwood in the United States in 1942 was approximately 16,800,000 cords. The amounts furnished by individual species are not available, but it is very probable that eastern spruce consumption, both domestic and imported, was substantially greater than in 1940, possibly 20 percent greater.

[10] A cord of spruce pulpwood is considered to contain 300 board feet.

Probably about two-thirds of the eastern spruce pulpwood was red spruce. Maine is the leading State in the consumption of domestic eastern spruce pulpwood.

The use of eastern spruce in limited quantities for railroad ties, telegraph poles, veneer, fuel wood, cooperage,[11] and other products, in addition to the comparatively large amounts used for pulpwood and lumber, brings the total estimated annual consumption in recent years to approximately 7,000,000 board feet.

Properties.—The heartwood of red spruce is nearly white in color with a slight tinge of red. The sapwood is often difficult to distinguish from the heartwood but is commonly lighter in color. In normal mature trees the sapwood is about 2 inches thick. The heartwood of both white and black spruce is a pale-yellowish white with hardly distinguishable sapwood.

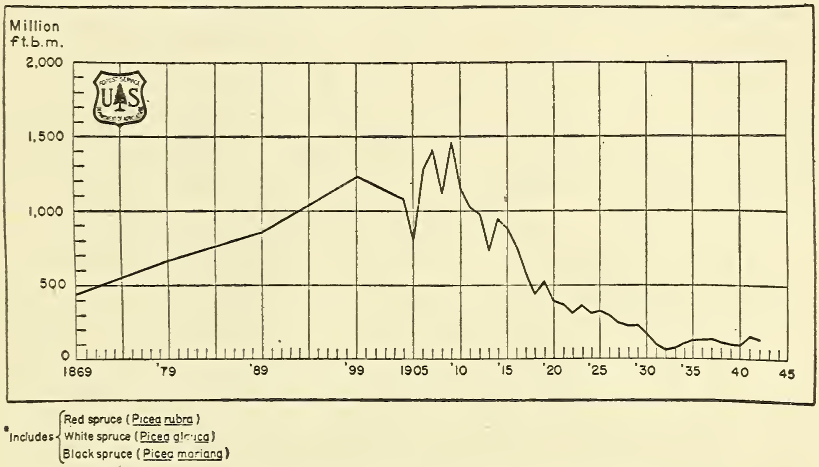

FIGURE 4.—Lumber production of eastern spruce 1869–1942.

The wood of all three of the eastern spruces has a uniform texture, is easy to work, free from pitch, and without taste, In the form of thin boards it has the quality of resonance to an exceptional degree. Eastern spruce is moderately light in weight,[12] moderately weak, moderately soft, moderately stiff, and moderately low in ability to resist shock. Although given a moderate rating in strength and stiffness, the wood is unusually high in these properties for such light weight. It has a moderately large shrinkage, but is easily air-dried or kiln-dried without warping or cupping and ranks next to the leading woods in ability to stay in place. It is low in nail-holding ability but can be readily glued.

As a paint-holding wood, eastern spruce ranks with ponderosa pine and Eastern and Western hemlock—below the cedars and white pines and above Douglas-fir and southern pine. In durability the heartwood of eastern spruce ranks with Eastern and Western hemlock in a group of woods between the intermediate and the nondurable groups.

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[11] Substantial quantities of spruce are used for cooperage but nearly all of it is Sitka spruce.

[12] The average weight of each of the eastern spurces when thoroughly air dry (12 percent moisture) is 28 pounds per cubic foot.

Both the sapwood and heartwood are difficult to penetrate with a preservative.

The wood of all the spruces can be readily reduced to paper pulp by any one of the commercial pulping processes.[13] The resulting pulps are strong, light in color, and can be easily bleached to a high degree of whiteness.

Principal uses.—Eastern spruce (largely red spruce) was used early in the history of New England in shipbuilding, principally for spars. Later, when the supply of white pine had been considerably reduced, eastern spruce lumber came into use for general purposes. Its outstanding uses in recent years have been for boxes and crates, and for construction lumber including boards, planks, dimension, and joists. Smaller amounts are used for furniture; sash, frames, doors, and general millwork; ladder rails; dairy, poultry, and apiary supplies; and refrigerators. For piano sounding boards and various musical instruments where a wood with a resonant quality is desired spruce is considered superior to all other woods. In the construction of airplane parts eastern spruce has largely given place to Sitka spruce, which can be obtained much more readily in long, clear pieces. Specialty uses of spruce, where lightness and stiffness are needed, combined with the requisite strength, are ladder rails, canoe paddles, light boat oars, and scaffold planks.

The largest use of eastern spruce is for paper pulp. The wood is pulped almost altogether by the sulfite and mechanical processes and is used in the manufacture of a wide range of products—from pulpboard, wrapping paper, and newsprint to high-grade book and writing papers and rayon. The growing scarcity of eastern spruce has brought about increasing importations from Canada and has stimulated research to find new and modified pulping processes applicable to other American woods still available in quantity.

The resinous exudations on trees of eastern spruce are used as chewing gum, and the extract made from the branch tips by boiling them in water forms the basis of spruce beer, formerly a popular beverage.

REFERENCES

FOREST LANDS OF THE UNITED STATES. United States Congress, Joint Committee on Forestry. 77th Cong., 1st sess., Senate Doc. 32, 44 pp. 1941.

HOW THE UNITED STATES CAN MEET ITS PRESENT AND FUTURE PULP-WOOD REQUIREMENTS. E. H. Clapp, and C. W. Boyce. U. S. Dept. Agr. Bul. 1241, 100 pp., illus. 1924.

A NATIONAL PLAN FOR AMERICAN FORESTRY. U. S. Forest Service. 73rd Cong., 1st sess. Senate Doc 12, 2 v. 1933.

THE RED SPRUCE: ITS GROWTH AND MANAGEMENT. L. S. Murphy. U. S. Dept. Agr. Bul. 544, 100 pp. 1917.

WHITE SPRUCE. U. S. Forest Serv. Silvical Leaflet 15, 4 pp. 1908.

YIELDS OF SECOND-GROWTH SPRUCE AND FIR IN THE NORTHEAST. W. H. Meyer. U. S. Dept. Agr. Tech. Bul. 142, 52 pp., illus. 1929.

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[13] Six processes are used commercially in making paper pulp from wood. One is the mechanical or ground-wood process, in which the wood is reduced to pulp on a grindstone. The yield approaches 100 percent of the weight of the wood. Four are chemical processes—the sulfite, sulfate, soda, and neutral sulfite. They depend upon the dissolving action of chemical reagents, which remove essentially all of the binding material (lignin) surrounding the cellulose fibers and leave them in a fairly pure state. The removal of the lignin is accomplished by cooking the wood chips with the proper chemical under steam pressure. The yield of pulp is about one-half the weight of the wood. In a sixth process, the semichemical, part of the lignin is removed by chemical means, and the resultant pulp, containing some lignin, is further refined by mechanical means. The yield of semichemical pulp is intermediate between the yields obtained with the mechanical process and the chemical processes.

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